Developing Flexibility

Blessed are the flexible for they shall not be bent out of shape.
—Author unknown

Study Questions

You will have successfully mastered this chapter if you can answer the following:

1. What are the benefits of and five cautions for stretching?
2. What factors affect flexibility?
3. What are the two types of flexibility?
4. What are the four types of stretching?
5. What are some basic guidelines for flexibility development?
6. What are the five principles of flexibility development?
7. What are five flexibility exercises for basic fitness?
8. Can you differentiate between the safe and contraindicated exercises illustrated in the chapter?
9. What are the general guidelines for identifying exercises that increase risk of injury?
10. How do flexibility and muscular fitness contribute to wellness?

You will find the answers as you read this chapter.

Visit the Online Learning Center for A Fit Way of Life, www.mhhe.com/robbinsfit2e, where you will find additional quizzes and study aids.

Terms

- active stretching
- collagen
- dynamic flexibility
- dynamic stretching
- elastic elongation
- elastin
- golgi tendon organ (GTO)
- inverse stretch reflex
- muscle spindle
- passive stretching
- plastic elongation
- proprioceptive neuromuscular facilitation (PNF)
- reciprocal inhibition
- static flexibility
- static stretching
- stretch reflex
Flexibility, the ability to move the joints through their full range of motion, is an important factor in achieving wellness throughout the life span. It enables us to reach, bend, twist, and perform movements without excessive tightness or stiffness. As children, we are naturally flexible, but as we age, flexibility tends to decrease. Disuse, injury, scar tissue, excessive body fat, and muscle imbalances are common factors associated with loss of range of motion. This chapter covers many aspects of flexibility—its benefits, types, cautions, principles, and guidelines. In addition, it highlights illustrated programs for developing this important component of fitness.

**FLEXIBILITY**

You can maintain youthful flexibility by incorporating stretching into your regular workouts. The flexibility exercises in this section are grouped as follows: a basic fitness flexibility program with exercises for joggers, walkers, aerobic dancers, cyclists, swimmers, and water exercisers and examples of PNF partner-assisted stretches. Contraindicated exercises, safer substitutes, and general rules for identifying common exercises that put back and joints at increased risk of injury are also discussed.

**Benefits of Flexibility**

Several benefits can be gained from flexibility development:

- **Decreased aches and pains.** Tight, inflexible muscles pull unevenly across joints, causing skeletal misalignment, poor posture, unnecessary fatigue, and muscle and joint pain. Stretching can alleviate these problems.
- **Enhanced ability to move freely and easily** and to perform activities such as bending down to tie your shoes, scratching your back, and turning to look back as you are driving.
- **Possible decreased risk of injury.** When tight muscles restrict the natural range of motion of a joint, the slightest unusual twist can cause a strain or pull, such as a strained hamstring. Inflexibility also is a precipitating factor in overuse injuries such as tendinitis, because inelastic muscles transfer excessive stress to even less pliable connective tissue.

Some research indicates that the importance of stretching in injury prevention may vary depending on the type of activity to follow. It may be more important in activities involving vigorous jumping and bouncing (like soccer or basketball) in which the muscle-tendon unit undergoes high-intensity stretch-shortening cycles. It may be less important in activities with limited demands for stretch-shortening cycles (e.g., jogging, walking). While the effects of stretching in injury prevention are controversial and research has generally not shown that stretching before exercise decreases risk of injury, a long-term flexibility program designed to alleviate muscle tightness and imbalance can offer benefits. Excessively tight areas, identified by flexibility assessment, can be corrected and adequate flexibility restored for sports and daily activities. Many rehabilitation professionals would agree that injury resistance is best enhanced by including in your weekly workouts exercises designed to enhance both flexibility and strength as part of a balanced muscular fitness program.

- **Recovery from injury.** Athletic trainers and physical therapists commonly utilize stretching in injury rehabilitation programs. Research has shown that gentle stretching in a pain-free range of motion is important in shortening the rehabilitation period after injury. This enables a person to more quickly regain normal range of motion and return to activity.
- **Enhanced athletic performance.** In racquetball, golf, tennis, volleyball, and swimming, greater range of motion and ability to apply force through that range of motion can confer a winning edge. However, research indicates that stretching routines preceding strength-dependent activities appear to decrease subsequent performance. Therefore, it may be best to minimize stretching prior to competitive events and to delay stretching for flexibility until after strength-building exercise sessions.
- **Reversal of age-related flexibility declines.** We tend to lose flexibility as we age, partly due to age-related changes in connective tissue and muscle, partly due to decreasing levels of activity. A regular stretching program can improve flexibility at any age.
- **Improved posture, appearance.** We look and feel better when we carry ourselves tall with shoulders back, chest high, and back straight. Unfortunately, over time, we may tend to “sag into gravity” and develop a “hunched over” appearance with rounded shoulders, forward head, and sagging abdominals. Muscle tightness across the chest, hamstrings, and lower back coupled with weakness of opposing muscles can contribute to and perpetuate poor postural habits. Over time, poor posture tends to worsen and becomes harder to self-correct as muscle imbalances increase. Stretching to correct shortened muscles, along with strengthening the weak opposing muscles,
can enhance posture and help a person “stand tall” naturally without continual conscious effort.

✓ Decreased muscle soreness after exercise. Research has shown that delayed onset muscle soreness and stiffness that occurs 1–2 days after exercise can be decreased by stretching the affected muscles.

✓ It feels good. Stretching reduces muscular tension, promoting relaxation.

Cautions

If carelessly done, stretching may cause injury. You must be careful not to overstretch, particularly when muscles are cold and tight. Stretch just to the point of tightness and hold. Stretching is not a competitive activity, so don’t try to imitate the most flexible person in your class. Injured areas should be stretched with great care and not into pain, which risks reinjury. If you feel pain during stretching, particularly joint pain, stop!

While less flexible individuals may envy those who can do splits with ease, keep in mind that more flexibility is better only up to a point. There is concern that excessive flexibility, unless accompanied by muscular strength, may overstretch ligaments and tendons and increase joint laxity and susceptibility to injury. For this reason, it is wise to strengthen muscles that you stretch and to stretch muscles that you strengthen for optimal fitness benefits.

Be aware that some studies show that static stretching immediately preceding strength activities decreases performance approximately 10 percent. Studies also show decreased vertical jump performance immediately following PNF stretching. Therefore, delaying stretching until after competitive or strength-dependent activities would enable a person to maintain flexibility without affecting strength or athletic performance.

Factors Affecting Flexibility

Several factors affect joint flexibility. These include joint structure, soft tissues (joint capsule, muscle, tendon), inactivity, muscle temperature, age, genetics, gender, obesity, injury, and neural factors.

Joint Structure

The range of motion of joints varies from one joint to another depending on joint structure, the joint capsule, and connective tissues of the muscle-tendon structures surrounding the joints. Some joints, like fingers or the elbow, are hinged for flexion and extension. Others, like the shoulder, a ball-and-socket joint, are more mobile and permit motion in several planes. The joint capsule is connective tissue that surrounds the joint and gives it stability while controlling mobility. If joint structure alone determines range of motion, stretching would not be effective, as this is not amenable to change. However, stretching does affect the range of motion of soft tissues surrounding a joint.

Soft Tissues

Muscles and their fibrous sheaths of connective tissue, ligaments, tendons, and skin surrounding a joint also affect its range of motion. It is estimated that about 47 percent of a joint’s total resistance to stretching is contributed by ligaments and the joint structure, about 41 percent from connective tissue, 10 percent from tendons, and 2 percent from skin. Muscle contains elastin, elastic fibers, and collagen, fibrous connective tissue. Like an elastic band, when stretched, muscles temporarily lengthen, then return to their resting length. Most of the resistance to stretching that we feel comes from fibrous connective tissue within and covering muscles. Repeated stretching over time increases the ability of a muscle to be lengthened with less resistance.

Inactivity

Physically active individuals tend to be more flexible than sedentary individuals. Perhaps the most common cause of low flexibility is a sedentary lifestyle. With disuse, the body adapts to a limited range of motion. Muscles and connective tissue become less pliable, shorten and weaken, leaving a person more susceptible to injury.

Muscle Temperature

Stretching is easier and more comfortable if muscles have been warmed up first by large-muscle activity such as walking or light calisthenics. When muscles are cold, they are stiffer and more resistant to stretching. As muscle temperature increases, connective tissue becomes softer, and resistance to stretching decreases by as much as 20 percent. Heat with stretching relaxes collagen fibers and allows increased elongation. Stretching alone does not warm up muscles. For this reason, increasing deep-muscle temperature by adequate warm-up is probably more important in reducing risk of injury in the workout that follows than is stretching alone. Also, stretching during a cool-down may allow muscle collagen to restabilize toward its new increased length, making changes more permanent and longer lasting.

Age

As we grow older, we tend to lose flexibility, related partly to decreasing levels of activity with age and partly to connective tissue changes due to aging. It may be more difficult to turn to look back over the shoulder, to back a car out of a parking spot, to zip a back zipper, or to bend down to tie a shoe. A regular program of stretching can counteract these flexibility declines. Research has shown that range of motion can be improved at any age, even in the 80s and 90s.
Genetics
Some people seem to be naturally more flexible than others, even “double-jointed” (they aren’t, really). This may be due to inherited differences in joint structure and elasticity of connective tissue. While you may not be able to change your genetics, you can improve your flexibility within your genetically determined range of motion. People who have never been able to touch their toes may, for example, be able to get inches closer with practice but may never be able to wrap their palms around their feet without bending their knees.

Gender
Females tend to be more flexible than males throughout the life span. This may be due to gender-specific variations in joint structure.

Obesity
Excess body fat in and around joints and muscles can present a mechanical block to full range of motion. The excess tissue acts like a wedge, preventing full joint motion due to tissue approximation. Excessive muscle hypertrophy can likewise impede full joint range of motion.

Injury and Scar Tissue
Injury to muscles and joints results in decreased range of motion initially due to pain and guarding. Flexibility can be lost over time due to decreased use as the injury heals, causing muscles and connective tissue to tighten and weaken. Flexibility is also compromised by the formation of scar tissue, which is tighter, weaker, and less elastic than the original tissues.

Neural Factors
When a muscle is stretched, muscle spindles, stretch receptors within the muscle cells, are stimulated. They sense the amount and speed of stretch, and if a muscle is overstretched or stretched too fast, they activate the stretch reflex to prevent injury. The stretch reflex causes the muscle to contract to prevent overstretching the joint.

The golgi tendon organ (GTO), another type of receptor located within the muscle tendon, detects the amount of tension in a muscle. When excessive tension is placed on the muscle, the GTO triggers the inverse stretch reflex, causing the muscle to relax to prevent injury. GTO respond after the muscle spindles, and only if a stretch is sustained for 5 seconds or longer. The signal sent by the GTO overrides the signal by the muscle spindles, and causes the muscle to relax, underlining the effectiveness of sustained stretching. Muscle spindles and GTO have opposite effects and both monitor and maintain the muscle-tendon unit in a safe range of motion.

Another neural factor affecting muscle is reciprocal inhibition. Muscles work in pairs, and when one muscle contracts, through reciprocal inhibition, its opposing muscle relaxes to permit movement. For example, during a biceps curl, the triceps relaxes to permit the biceps to shorten. This effect is incorporated into some stretching programs, such as PNF, by consciously contracting a muscle to produce relaxation and increased range of motion in the opposing muscle group.

Types of Flexibility
There are two basic types of flexibility: static and dynamic. Static flexibility refers to the range of motion that can be achieved through a slow, controlled stretch. Dynamic flexibility is the range of motion achieved by quickly moving a limb to its limits.

Static stretching techniques are those in which you slowly stretch a muscle to the point of tension and hold, such as in holding a sitting hamstring stretch. The stretching force is provided by gravity or the force of one limb pulling on another. When a muscle is stretched and held at a constant length, after a period of time there is a gradual loss of tension and muscle lengthening. Static stretching is the most commonly used type of stretching. It does not activate the stretch reflex and is associated with limited muscle soreness. It does not increase muscle temperature, so some type of prior warm-up activity is recommended.

Dynamic stretching employs swinging or ballistic moves such as a high forward kick. Dynamic stretching is associated with increased muscle soreness, and is not used much in personal fitness programs because of increased risk of injury. Dynamic exercises may be useful in preparation for athletic activities requiring such moves, but they carry increased risk that a muscle or
joint could be overstretched, resulting in muscle or tendon tears and joint injury. Also, these exercises may initiate the stretch reflex, which may cause the stretched muscle to contract, limiting flexibility gains. While both types of stretching can increase flexibility, static stretching is preferred in health-related fitness programs because it is highly effective and carries little risk of muscle or joint strain.

Static and dynamic stretching may be performed actively or passively. With active stretching, you use your own muscle forces to stretch yourself. For example, you can actively stretch calves by sitting and flexing your ankles to pull the toes back. With passive stretching, someone or something else assists with a stretch. The assist could be gravity, body weight, a strap, or leverage: for example, using gravity or a slant board to assist with a calf stretch. You relax the muscle you are trying to stretch and use the external assist to apply force. Both active and passive stretching improve flexibility, but passive stretching is more commonly used.

Guidelines for Flexibility Development

Flexibility exercises are part of a balanced fitness program. The goal is to develop and maintain an adequate range of joint motion for ease of movement in your daily activities. Flexibility gains are proportional to the overload applied: to the frequency, intensity, and time (duration) of stretching.

Principles of Flexibility Development

Over time, a program of regular stretching can produce beneficial changes in muscle and joint range of motion. To develop an effective stretching program, several principles affecting flexibility development must be considered. These principles include progressive overload, specificity, reversibility, individual differences, and balance.
Progressive Overload

Improvement in joint range of motion can occur when sustained stretching produces elastic and plastic elongation. Elastic elongation, the temporary lengthening of soft tissue, occurs when muscle is stretched and returns to its resting length. Connective tissue within and surrounding muscle has both elastic and plastic properties. Longer or more intense stretching can produce plastic elongation, a semi-permanent lengthening of tissues. After a stretch is removed, elastic elongation reverses and plastic elongation remains. Plastic elongation is the goal of stretching programs. It is best obtained through static or slow, sustained stretching. The amount of plastic elongation is considered time-dependent and is proportional to the amount of force applied. If tissue is stretched to the point of tension but not pain (which may activate the stretch reflex) and held, the tissue will gradually relax and elongate, and require less force to maintain the new length. A prolonged stretch is needed to achieve plastic elongation.

Specificity

Flexibility is specific to a joint; that is, flexibility in one leg does not guarantee flexibility in the other leg, and flexibility in the shoulders does not ensure flexibility in the lower back. It is also specific to joint angles—a person who can do front splits may be less flexible in side splits.

Reversibility

Like any other fitness component, flexibility changes are reversible. If a person stops stretching, over time, range of motion will decrease back to levels sustained by daily activities. Gains from flexibility can be lost in as little as 3–4 weeks without stretching. On the other hand, flexibility can be maintained with stretching as few as 2–3 days per week.

Individual Differences

People vary in their ability to develop flexibility. Variations in proportions of collagen and elastin in
muscle tissue, joint structure, length of muscles, and attachment points of tendons on bones may contribute to differences in joint range of motion as well as ability to increase that range. Within your genetic endowment, you do have potential for improvement. A regular stretching program can help you enhance and maintain your flexibility within your genetically determined range.

**Balance**

We often have muscles that are tighter on one side of the body (right-left or front-back). Pay attention to flexibility differences and work to improve them. Your hamstrings may be tighter on one side than the other. It is common for chest muscles to be tighter than the opposing upper back muscles, and lower back muscles are often tighter than abdominals. Spend more time stretching the tighter areas to alleviate the imbalance.

**Flexibility Exercises for Basic Fitness**

As part of a warm-up or cool-down, exercises A through F are important for runners, walkers, and aerobic dancers. Cyclists, swimmers, and water exercisers should add upper-body stretches G through I. If time is limited, save stretching for the cool-down. For basic fitness flexibility, perform the full program of exercises in Figure 3-1. Hold each one 10 to 30 seconds and repeat at least four times. Lab 3-1 gives an introductory
flexibility session that you can incorporate into your routine.

A. Hamstring stretch
   Sit and extend one leg in front, with the other bent and tucked as shown in diagram (a). Keeping shoulders erect, press abdomen forward. Hold. Repeat with other leg.

B. Lower back/hip flexor stretch
   Lie on your back with one leg straight and one bent. With hands behind thigh, press thigh toward chest. Keep extended leg straight. Repeat left.

C. Spinal twist (lower back and hip abductors)
   Sit with right leg extended, step left leg over right, and turn upper body toward left. Repeat on other side.

D. Quadriceps stretch
   Stand with right leg bent at the knee. With left hand, pull right heel toward buttocks. Keep shoulders up, abdominals tight, and hips tucked under to prevent back hyperextension. Omit if you have knee problems.

E. Calf/achilles stretch
   Standing in forward lunge position, toes pointing forward, press heel toward floor. Repeat with other leg. Bend back knee to stretch soleus.

F. Iliotibial band stretch
   Cross left foot over right, press hips to right. Repeat with other side.

G. Deltoid stretch
   Cross right arm in front of body and pull it in toward midline with left hand.

H. Pectoral stretch
   Place right hand on wall, with elbow extended but not locked. Twist shoulders left. Repeat with left arm.

I. Triceps stretch
   Pull left elbow behind head. Repeat right.

PNF Partner-Assisted Stretches

A type of static stretching called proprioceptive neuro-muscular facilitation (PNF), a partner-assisted stretch often used by athletic trainers, is highly effective for increasing flexibility. It utilizes the nervous and muscular systems to facilitate stretching. It was developed by Herman Kabat, M.D., and two physical therapists in the 1940s for use on paralysis patients to improve flexibility and strength. PNF utilizes the inverse stretch reflex produced by golgi tendon organs to relax the target muscle and allow a greater stretch. It is thought that when the muscle is first stretched, then contracted, the GTO reflexes are stimulated, relaxing the muscle. To perform a PNF contract-relax stretch, you first perform a 10- to 30-second static stretch, then contract the muscle for 6 seconds to produce fatigue, and then relax while a partner stretches your limb for 10 to 30 seconds. The forced contraction fatigues the muscle and increases the muscle’s ability to relax while being stretched.

Another type of PNF stretching called the contract-relax-agonist contract inserts a contraction of the opposing muscle group before the final stretch; for example, in the hamstring stretch (A) below, after contracting hamstrings, the person would contract quadriceps, pulling the leg back as far as possible for about 10 seconds. If the quadriceps is contracted, through reciprocal innervation, the hamstring relaxes even more and can be passively stretched to a greater range of motion. Some research indicates that the contract-relax-agonist contract method is the most effective PNF technique.

For safety, be sensitive to your partner’s needs and flexibility levels. Be sure to communicate when more or less resistance or pressure is needed throughout each exercise. Work with the same partner throughout the series. Switching partners can lead to injury because of unfamiliarity with the flexibility limits of the person being stretched. Some examples of PNF stretches are illustrated in Figure 3-2.

A. Hamstring stretch
   Lie on your back and lift one leg into the air. Partner supports ankle and knee in a static stretch. Next, keeping knee extended but not locked, push against your partner as he or she resists. Stretch and then relax as partner eases leg into a new stretch.

B. Inner thigh stretch
   Sit with knees out and bottoms of feet together. Press down on knees in a static stretch. Next, partner kneels behind and resists on knees as you press them upward. Finally, relax as partner gently presses them toward the floor in a stretch.

C. Gluteal/lower back stretch
   Sit cross-legged and stretch forward. Partner kneels behind you with hands on your upper back. Next, resist back against partner. Then stretch forward as partner assists.

D. Pectoral stretch
   Sit cross-legged with fingers interlaced behind your head and back, supported by partner’s thigh. Partner gently pulls your elbows back for 10 seconds and then resists as you attempt to pull them forward. Next, relax as partner gently stretches them back.

Other Programs for Enhancing Flexibility

Tai Chi and yoga are very old yet newly popular activities that can enhance flexibility and balance as well as reduce stress.
Tai Chi is an ancient Chinese exercise known for its slow, graceful movements. It originated as a self-defense activity but now is used to enhance standing balance, flexibility, lower-body strength, and neuromuscular control. It is a good exercise for people of all ages and can be enjoyed throughout the lifetime.

Yoga, which means to yoke or unite, is another ancient art with several branches, each with its own style. Hatha yoga is the most widely practiced in the United States. It involves using mental focus and coordinated breathing while assuming a series of physical postures. Some people do yoga to reduce stress, others to improve flexibility and balance. Some forms of yoga are more vigorous than others; some are more relaxing. If one type doesn’t appeal to you, investigate others.

One way to get started in yoga or Tai Chi is to enroll in a class. Either can be learned at a beginning level in a few weeks of instruction, though mastery may take years. Instructional videotapes are available for home use and can be obtained at a video store. The Yoga Sun Salute, a series of yoga poses, is pictured and described in Lab Activity 3-2 for you to experience.

CONTRAINDICATED EXERCISES

A few stretching and toning exercises added to an aerobic program can promote balanced fitness by increasing flexibility in tight muscles and strengthening weak ones. However, not all conditioning exercises commonly done in classes or seen on videotapes are good for everyone. These potentially harmful exercises are labeled contraindicated exercises.

Realize that there are exceptions to these guidelines. Some individuals are well conditioned and able to minimize risk in these moves. For example, a competitive hurdler needs to practice hurdle stretches for the sport, and a dance or yoga student will have an instructor make sure that the positioning is safe. The body is able to move safely in many directions. For example, we are rarely injured by squatting down or bending over to pick up a shoe. Likewise an occasional standing toe touch will be harmless for most people, but if high risk moves are practiced repeatedly, day after day, the risk of injury increases, particularly in those with preexisting joint problems.

By studying people with aches and injuries, fitness experts have learned that some common stretching and
1. **Yoga plow:** Sometimes done as a back stretch, this exercise can injure discs, ligaments, and nerves in the neck and back. A better back stretch is a single-or double-knee tuck to the chest.

2. **Knee tuck to chest:** Hyperflexing the knee by pulling it to the body with the arms or hands placed on top of the tibia places undue stress on the knee joint. Note: The hand position should be changed to hug the thigh rather than the shin.

3. **Head roll:** Hyperextension can injure discs in the neck. Safer neck stretches include half-head rolls to the front, turning the head side to side so that the chin touches the right and left shoulders, and touching an ear to each shoulder.

4. **Hurdler stretch:** This stretch can cause groin pull, injure knee cartilage, and overstretch the medial collateral ligament—the one that helps stabilize the knee. It may also cause hip joint discomfort because the femur of the leg that is tucked behind is in a position of extreme rotation in the joint capsule. The alternative hurdler stretch safely stretches hamstrings.

Contraindicated exercises should be avoided. Others should be modified for safety and effectiveness. Be aware of which commonly done high-risk movements you should avoid and which high-benefit, low-risk exercises you should do instead. Figure 3-3 shows some examples of each.

Your body is meant to move in many ways—to bend, twist, and stretch. Some people can do high-risk
exercises for years with no ill effects. For others, after only a few repetitions, injury occurs. You may not know into which category you fit until it is too late. The problem is that some movements increase risks to muscles, joints, and connective tissue. While you may need to do deep squats if you are a competitive weightlifter or a yoga plow if you are in a yoga class, these moves don’t offer any special benefit for the fitness exerciser. Low-benefit, high-risk exercises should be minimized in programs designed to emphasize personal fitness. Follow these general rules when exercising:

1. Do not hyperflex the knee.
2. Do not hyperextend the knee, neck, or lower back.
3. Do not apply a twisting or lateral force to the knee.
4. Avoid holding your breath during exercise.

5. **Full squat**: Excessive flexion or extension of the knee is dangerous. To strengthen the quadriceps, substitute half-knee bends for full squats, the duckwalk, deep lunges, and squat thrusts. Deep knee flex-ion exercises overstress knee ligaments and cartilage.

6. **Standing toe touch**: This exercise risks the straining of back ligaments. Limit forward flexion in a standing position. As your trunk dips below a 25- to 45-degree angle, the lower back muscles cease to work and the posterior ligaments joining bone to bone must support the load.

7. **Leg stretches at a ballet bar (or other high object)**: These may be potentially harmful. When the extended leg is raised 90 degrees or more and the trunk is bent over the leg, it may lead to sciatica problems, especially when the exerciser has limited flexibility. Substitute the back and hamstring stretches suggested in 1, 4, and 6.
8. Leaning forward and twisting the trunk to the side: These moves are particularly hazardous to the lower back, adding a shearing force to the stress on back ligaments. Avoid swinging hands and the trunk through the knees, windmill toe touches, waist circles, and elbow-knee lunges. There is no exercise you can do standing to tone your waist. The most effective exercise for reducing the waist is aerobic exercise and sensible nutrition. To tone oblique abdominals, the muscles that underlie the waist area, use twisting bent-knee abdominal curls. Lying on your back with heels close to your buttocks and crossing your arms across your chest (or with a hand touching each shoulder), curl the shoulders first toward the right knee and then toward the left knee.

9. Double-leg lifts, straight-leg sit-ups, and low leg scissors: These do little or nothing to tone the abdominals. They tighten hip flexors, which in most people are too tight already, causing lordosis (swayback). They may also cause lower back strain. The most effective exercise for toning abdominals is bent-knee abdominal curls in which the lower back stays on the ground while the shoulders curl forward about 3 inches. To avoid jerking on the head or neck, cross your arms across your chest or behind your head with a hand touching each shoulder.

10. The swan arch, prone double-leg raises, and yoga cobra: These produce excessive back hyperextension and possible back strain. In a prone position, raise your right arm and the opposite leg a few inches off the ground and then switch; this will strengthen the back safely.

11. Donkey kicks or fire hydrants: Done on hands and knees with the back hyperextended, these may strain the lower back. To protect the back, hold your abdominals tight, round your back, and raise your leg no higher than 6 to 12 inches.
5. Avoid stretching long/weak muscles (e.g., abdominals) and avoid shortening already short/strong muscles (e.g., hip flexors). See common muscle imbalances in Table 7-2.
   a. Most people should avoid aggravating common postural faults: forward head, dorsal kyphosis (rounded upper back), medial rotations of the thigh, and pronation of the foot.
   b. Most people need to stretch the chest muscles, hip flexors, calves, hamstrings, lower back, and medial thigh rotators.
6. Avoid stretching any joint to the point of pain.
7. Be especially careful when using passive stretches with another person (unless the person is a physical therapist).
8. Avoid movements that place acute compressional forces on spinal discs, such as extending and rotating the spine simultaneously (e.g., trunk and neck circling and double-leg lifts).
9. Avoid movements that cause joint impingements or cartilage damage, such as arm circles in the palm-down position.
10. If the nature of your sport regularly requires the violation of good mechanics (baseball catcher assuming a deep squat position or gymnast performing double-leg lifts), make certain the muscles are as strong as possible to endure the stress.

PRESCRIPTION FOR ACTION

You’ve read the chapter. Now go do one or more of these.

- While studying or reading the morning paper, sit on the floor and stretch hamstrings.
- While on the phone, do calf and quadriceps stretches.
- If you have a desk job, take a 5-minute stretch break every hour—do ankle circles, half head rolls, and shoulder stretches.
- After every hour of computer use, stretch wrists, back, and shoulders.
- While watching TV, stretch during commercials.

Frequently Asked Questions

Q. **Is it possible to become too flexible? Is that a problem?**
   A. It is possible for the muscles and connective tissue surrounding a joint to become too flexible. Joints are constructed to move within a certain range of motion. Excessive motion can damage tendons and ligaments and tear the joint capsule. Once a muscle has been stretched to its maximum length, further stretching will only loosen tendons and ligaments (which you do not want to stretch), which can cause joint instability and increase the risk of injury. There is a trade-off between flexibility and stability. The greater the joint’s range of motion, the less stable the joint is structurally and the more it must rely on the muscles supporting it to control the range of motion. For example, the shoulder has relatively high flexibility compared with the hip, which has greater structural stability. Shoulder dislocation is fairly common; hip dislocation is not. If the muscles and connective tissue become very extensible, there is a measure of safety as long as there is sufficient muscular strength to control the movement. For example, gymnasts are very flexible but also develop strength to control that range of motion. If you wish to develop greater than average flexibility for a sport or physical activity, it is important to strengthen the muscles that you stretch (and vice versa) for balanced fitness.

Q. **What are the advantages and disadvantages of stretching with a partner?**
   A. On the plus side, stretching with a partner adds a social element that makes it more fun. It’s a good way to get to know your classmates if you stretch with different people. You can relax while your partner stretches you, so you may get a better stretch. On the minus side, you and your partner must communicate well to minimize the risk of overstretching, and stretching with a partner takes longer than stretching alone. A good compromise is to do a few partner stretches along with individual stretches.

Q. **If I am short on time, is it better to stretch before or after exercise?**
   A. When you stretch before exercise, the muscles tighten up again during the workout. After exercise, the muscles are warmer, more extensible, and stretching is easier. Also, if you stretch muscles during cool-down, the flexibility changes tend to be longer lasting (plastic elongation) than if you stretch before exercise.
Q. How important is stretching in my training program?
A. Research does not conclusively demonstrate that stretching prevents injury. However, we tend to lose flexibility and move more stiffly as we age, and regular stretching prevents this loss. Maintaining youthful flexibility can enhance your ability to perform daily activities, such as turning to look as you are backing up your car. It also enhances performance of athletic activities—making it easier to get a full stride as you run or a full reach in swimming. Being able to apply forces through a full range of motion gives more power to athletic skills.

Summary

Flexibility is an important asset in fitness and daily activities. It enhances the ability to move freely and easily, aids with posture and appearance, helps with recovery from injury, and can reverse joint stiffness and tightness that creeps up over time. Factors that affect flexibility include joint structure, soft tissues, inactivity, muscle temperature, age, genetics, gender, obesity or excessive muscle hypertrophy, injury and scar tissue, as well as neural factors. Flexibility gains are proportional to the overload applied, to the frequency, intensity, and time of stretching. While static stretching is recommended for most fitness activities, dynamic stretches may be used for certain athletic activities, and both types may be done either passively or actively. Principles of flexibility development include progressive overload, specificity, reversibility, and balance. A series of stretches for basic fitness was given, as well as PNF partner-assisted stretches. Some potentially harmful or contraindicated exercises that put joints at increased risk of injury, and guidelines for identifying them, were also discussed.

Internet Resources

About, Inc.  
http://sportsmedicine.about.com/od/flexibilityandstretching  
Information about how and why to stretch, benefits and limitations, as well as sample flexibility routines.

American College of Sports Medicine  
www.acsm.org  
Information on sports research, health and fitness, aerobic exercise guidelines, and a quarterly fitness newsletter. “Current Comments” gives information on a variety of exercise topics of recent interest.

International Fitness Association  
www.ifafitness.com  
Provides information about physical fitness, strength training, types of stretching, and the physiology of stretching.

Mayo Clinic  
www.mayoclinic.com  
Videos on stretching for the office and slide shows showing stretching exercises.

Women’s Heart Foundation  
www.womensheartfoundation.org  
Information and illustrations on stretching as a part of warm-up; also general information on strength building and exercise safety.
Introductory Flexibility Session

Equipment Needed:
Mat

Procedure
Read Chapter 3, warm up, and then complete these exercises as illustrated in Figure 3-1. Hold each stretch 10 to 30 seconds and repeat four times. You can tear out this lab and follow the exercise descriptions on the back of this page.

FLEXIBILITY EXERCISES

<table>
<thead>
<tr>
<th>Exercise</th>
<th>Repetitions</th>
</tr>
</thead>
<tbody>
<tr>
<td>A. Hamstring stretch</td>
<td></td>
</tr>
<tr>
<td>B. Lower back/hip flexor stretch</td>
<td></td>
</tr>
<tr>
<td>C. Spinal twist</td>
<td></td>
</tr>
<tr>
<td>D. Quadriceps stretch</td>
<td></td>
</tr>
<tr>
<td>E. Calf/Achilles stretch</td>
<td></td>
</tr>
<tr>
<td>F. Iliotibial band stretch</td>
<td></td>
</tr>
<tr>
<td>G. Deltoid stretch</td>
<td></td>
</tr>
<tr>
<td>H. Pectoral stretch</td>
<td></td>
</tr>
<tr>
<td>I. Triceps stretch</td>
<td></td>
</tr>
</tbody>
</table>

See back of page for instructions.

Results

1. What stretches were the most challenging due to muscle or joint tightness?

2. What stretches were easiest for you? You will want to maintain this flexibility.

3. Considering your own tight or flexible areas, as well as the rule of specificity, which are the most important stretches for you to incorporate into your exercise program?
A. Hamstring stretch
   Sit and extend one leg in front, with the other bent and tucked as shown in diagram (a). Keeping shoulders erect, press abdomen forward. Hold. Repeat with other leg.

B. Lower back/hip flexor stretch
   Lie on your back with one leg straight and one bent. With hands behind thigh, press thigh toward chest. Keep extended leg straight. Repeat left.

C. Spinal twist (lower back and hip abductors)
   Sit with right leg extended, step left leg over right, and turn upper body toward left. Repeat on other side.

D. Quadriceps stretch
   Stand with right leg bent at the knee. With left hand, pull right heel toward buttocks. Keep shoulders up, abdominals tight, and hips tucked under to prevent back hyperextension. Omit if you have knee problems.

E. Calf/achilles stretch
   Standing in forward lunge position, toes pointing forward, press heel toward floor. Repeat with other leg. Bend back knee to stretch soleus.

F. Iliotibial band stretch
   Cross left foot over right, press hips to right. Repeat with other side.

G. Deltoid stretch
   Cross right arm in front of body and pull it in toward midline with left hand.

H. Pectoral stretch
   Place right hand on wall, with elbow extended but not locked. Twist shoulders left. Repeat with left arm.

I. Triceps stretch
   Pull left elbow behind head. Repeat right.
Hatha Yoga Workout: Sun Salutation (or Salute to the Sun)

Introduction: The Sun Salutation, one of the most popular yoga routines, is a series of 12 postures (poses) performed in a single, graceful flow. Each movement is coordinated with the breath. Inhale as you extend or stretch, and exhale as you fold or contract. Complete the instructions below and answer the questions. The Sun Salutation is on the back of this page. This is a tear-out exercise that may be used anywhere.

1. Go through the Sun Salutation routine slowly several times. One complete routine consists of two sequences: one for the right side of the body, and one for the left. Concentrate on the proper order of the poses during this initial practice session.
2. Now practice the routine concentrating on inhaling and exhaling at the correct time.
3. Describe how the arms and shoulders feel after going through this yoga workout.
4. Were you able to step each leg up between the hands in one movement on the Lunge pose?
   Yes/No  Discuss:

5. Were you able to press the heels of the feet down to the floor on the Downward Dog pose?
   Yes/No  Discuss:

6. What is your evaluation of the Sun Salutation as a strength and flexibility exercise routine?

7. Is there any way to make this routine aerobic? If so, how?

8. How could this routine help with stress management?
Sun Salutations

1. Mountain
   - Stand with feet together, slightly pigeon-toed (big toes touching, heels apart), with your hands together, palm to palm, at heart level. Take several deep breaths. Exhale.

2. Slight Arch
   - Inhale. Tighten buttocks, stretch arms upward, gently arching your back as far as feels comfortable and safe.

3. Standing Forward Bend
   - Exhale, while bending forward and downward, bringing your hands flat to the floor beside your feet, bending the knees if necessary. Touch head to knees, if possible.

4. Lunge
   - Inhale and step the right leg back in a wide backward lunge. Keep left foot between hands.

5. Plank
   - Exhale and step left leg back into plank. Inhale. Hold the position and breathe. Tighten abs.

6. Knees and Chest
   - Hold your breath and lower the body in one unit, close to the floor. Exhale as you touch knees, chest, and chin to the floor. Lower hips, point feet and toes.

7. Cobra
   - Inhale, lifting your chest toward the sky, with elbows slightly bent and pressed into your ribs. Straighten arms as much as feels comfortable.

8. Downward Dog
   - Exhale, tuck toes under lifting hips up and bringing the body into inverted V. Align head with arms. Press heels down.

9. Lunge
   - Inhale. Lift head and step the right foot up between hands.

10. Standing Forward Bend
    - Exhale. Bring the left foot up and go into standing forward bend.

11. Slight Arch
    - Inhale. Rise slowly. Tighten buttocks, lift arms overhead, and arch back.

12. Mountain
    - Exhale. Return to position number 1. Repeat the sequence, stepping with the left leg.